



The College Board

AP[®] Computer Science Principles

Draft Performance Tasks

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Computer Science Principles

Performance Task: Investigate — Bits to Information to Knowledge

Computing enables and empowers new methods of information processing that have led to monumental change across disciplines, from art to business to science. Managing and interpreting an overwhelming amount of raw data is part of the foundation of our information society and economy. People use computers and computation to translate, process, and visualize raw data, enabling new understandings that in turn contribute new knowledge to the world.

For this task, you and a partner will research and work with data that is of interest to you. You will use appropriate computational tools and techniques to transform the raw data into information and knowledge.

General Requirements

- You must develop and submit one collaborative document.
- You must develop and submit two individual documents.
- You must work in pairs on the collaborative portion of this project. A group of three is only allowed if there are an odd number of students in the class.
- Your team must identify an area of focus, and both the collaborative and individual reports must share that same area of focus.
- You must work alone on the individual portions of this task. You must write the individual report and reflection on your own.

Prepare and submit the following:

Collaborative Submission

For this submission, each group member will submit identical documents.

Along with a partner, identify and describe a set of questions you will investigate to gain insight and knowledge from publicly available data. See the Collaborative Investigation section (**A**) for details.

Submit a report that describes the details of your investigation and communicates your findings. See the Collaborative Report section (**B**) for details.

Individual Submission

Produce a detailed description and justification of the tools and techniques your group used in the investigation, including a description of how your group achieved its results.

See the Individual Report section (**C**) for details.

Submit a written description and analysis on the collaborative aspects of the investigation.

See the Individual Reflection section (**D**) for details.

A. Collaborative Investigation

1. Develop a set of three to five non-trivial questions that will provide the focus of the investigation. These questions should reflect the rationale for your investigation and will determine the overall direction of your research; it is therefore important for you to think carefully about them. Your questions should enable you to investigate different attributes of the data you select, not just *different properties of the same data attribute*. For example, asking for the minimum, maximum, and median value of temperatures would not count as different attributes, since the questions all refer to temperatures.

You will be evaluated on the quality and richness of your questions. The answers to the questions you ask should provide insight or knowledge about the area being investigated.

Note: It is highly unlikely that questions that simply count data items will lead to great insight. Furthermore, questions that yield only Yes/No answers can often bias the answer toward a particular direction and overlook the subtlety of the data itself. For example, if the answer is mostly *Yes*, but sometimes *No*, it might be very important *when it's No*. You may have to consider factors that led to the *No* answer and whether a *No* answer has additional implications.

2. Find one or more large data set(s) that will allow you to obtain answers to your questions. You must use a data set that begins with at least 1000 data values, where a data value is considered a cell in a table. You may use more than one data set. You must use a publicly available, permanent data set or sets from a credible source that supports a meaningful investigation.
3. Apply computational tools and techniques to answer your questions (e.g., by finding patterns in the data, by transforming or translating data, by creating visualizations, or by finding connections between the data and other sources of knowledge).
4. Apply computational tools and techniques to create non-textual representations that communicate the results of your investigation. Use tables, diagrams, charts, graphs, visualizations, or any other appropriate representations to communicate insight and knowledge gained from data.

Your technique(s) should be able to handle data that is 10, 100, or 1000 times larger than your original dataset. Avoid the simpler approaches of looking at the raw data, manually performing the analysis, or manually creating the non-textual representations.

B. Collaborative Report

As a group, respond directly to each of the following prompts. This report will provide the details of your investigation and should include non-textual representations that communicate the results of your investigation. These representations could include charts, tables, graphs, visualizations, or other appropriate resources that augment or clarify your questions, analysis, and answers.

September 2013

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1. Describe the area of focus you and your partner chose to explore and explain why you chose this area. Your answer should be no more than 200 words.
2. List the set of three to five questions you sought to answer.
3. Identify each permanent data set you used. **For each set**, you must:
 - a. Provide the permanent URL.
 - b. Briefly describe the data set. Each description should be no more than 100 words.
 - c. Provide the date on which you accessed each data set.
4. Clearly present the answer to each of the questions you investigated. Each answer should be no more than 200 words. Attach and reference any appropriate non-textual representations. Include a one sentence description of each non-textual attachment.
5. Explain how your questions and answers contribute to the development of insight and knowledge in your chosen area of inquiry. Your explanation should be no more than 300 words. Attach and reference any appropriate non-textual representations (maximum of 2 pdfs). Include a one-sentence description of each non-textual attachment.

C. Individual Report

On your own, respond directly to each of the following prompts.

1. Explain why your questions are rich enough and your data set(s) are large enough to require the use of computation to analyze the data and answer your questions. Your explanation should be no more than 200 words.
2. Explain why your group selected the data set(s) used in your investigation. Your explanation should be no more than 200 words.
3. Describe and analyze the specific computational tools (visualization software, spreadsheet, statistical package, etc.) and techniques (filtering, clustering, visualizing, analyzing, etc.) your group used. Provide a detailed description of how your group processed the information in the data set(s) to conduct the investigation and how this process enabled you to meet your objective of gaining insight and knowledge. This description should be sufficiently detailed to make it clear that you could conduct the investigation on your own. It should also include sufficient detail to allow a reasonably skilled reader to use the tools and techniques to replicate the investigation and verify the results. Your description should be no more than 700 words; the following questions may help guide your writing.
 - a. What challenges did you face in finding the data sources?
 - b. Did the data require any filtering or cleaning? If so, how did you process the data?

September 2013

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- c. Did you do any clustering or classifying of your data? If so, how?
- d. Did you translate or transform the data to determine patterns? If so, how?
- e. Did you use any tools to visualize your data? If so, which tools? How did you use them?
- f. Was the size of your data set a challenge? If so, how did you address the challenge?

D. Individual Reflection

Write a brief reflection essay in which you describe the collaborative process your group used to do the research. Include answers to the questions below. Your response should be no more than 300 words.

- a. How did you share or divide the work?
- b. What was the most significant piece of information that you shared with your partner about the work that you, individually, performed that contributed to your group's research?
- c. What was the most significant piece of information your partner shared with you about the work that he or she, individually, performed that contributed to your group's research?
- d. What was the most significant question you asked – or most significant feedback you provided – that helped your partner review and revise his or her work?
- e. What was the most significant question your partner asked – or most significant feedback he or she provided – that helped you review and revise your work?

Learning Objectives

The **Investigate — Bits to Information to Knowledge** Performance Task addresses the following Computer Science Principles Learning Objectives (LOs):

LO 1.1.1 Use computing tools and techniques to create artifacts. [P2]

LO 1.1.2 Collaborate in the creation of computational artifacts. [P6]

LO 1.2.1 Use computing tools and techniques for creative expression. [P2]

LO 2.3.1 Use models and simulations to raise and answer questions. [P3]

LO 3.1.1 Use computers to process information to gain insight and knowledge. [P1]

LO 3.1.2 Collaborate when processing information to gain insight and knowledge. [P6]

LO 3.1.3 Communicate insight and knowledge gained from using computer programs to process information. [P5]

LO 3.2.1 Use computing to facilitate exploration and the discovery of connections in information. [P1]

LO 3.2.2 Use large datasets to explore and discover information and knowledge. [P3]

LO 3.3.1 Analyze the considerations involved in the computational manipulation of information. [P4]

Computer Science Principles

Performance Task: Explore — Implications of Computing Innovations

Computing innovations have had considerable impact on the social, economic and cultural areas of our lives. To focus your work on this task, select a computing innovation that interests you, that has had significant impact on our society, economy, or culture, and that possesses the potential for both beneficial and harmful effects.

General Requirements

- You must work alone on this performance task.
- The innovation you choose should affect a significant population (more than a few hundred people).
- You must include at least two references to a source of information that anyone can use to learn about the innovation you explored. Each reference must be to a source created between May 2013 and April 2014.

Prepare and submit the following:

An original digital artifact (e.g. music, image, video, infographic, presentation, program, web page) that you create to express the effects of your chosen innovation. See Artifact (**A**) for details.

A written document in which you respond directly to several prompts — elaborating on your chosen area, innovation, and the innovation’s impact. See Written Report (**B**) for details.

A. Artifact

However you choose to express the exploration of your innovation – as either a static or dynamic artifact – your work must reflect the innovation’s importance. Your artifact should demonstrate your thorough understanding of the innovation you chose; its impact on society, economy, or culture within the selected population; and its potential for beneficial and harmful effects. If your artifact is static, submit it as a pdf. If your artifact is dynamic, your final submission must be represented and submitted as a video you have created and uploaded, with a maximum length of 3 minutes. Submit the video using one of the following formats: .mov, .wmv, .mp4, or .avi.

Use the free screen capture software on each operating system platform. For example, on Mac OS you can use free QuickTime screen recording (.mov). On Windows operating systems, you can use Windows Movie Maker with the output format Windows Media Video (.wmv). Other options include screencast-o-matic.com (.mp4, .avi) or camstudio.com (.avi).

B. Written Report

Respond directly to each of the following prompts. Your document should be a maximum of 1000 words and it may include illustrations. Submit it as a single pdf file. Your report should convey a deep level of understanding about your innovation and its impacts.

1. Describe the social, economic, or cultural impacts of the innovation and their significance, using references to support your argument.
 - a. Select at least two references to provide context for the innovation you investigated. Each source must be a high-quality newspaper/magazine article, book, or online source.
 - b. Provide the full citation, identifying the author, title, and source for each reference. For online references, include the permanent URL and the date on which you accessed the reference.
2. Analyze how the computing innovation affects communication, behavior, awareness, or knowledge within the population you identified.
3. Describe how the technology works for your chosen innovation, including the levels of abstraction represented in the design of the innovation and a description of the sequence of steps for at least one algorithm.
4. Describe how your artifact expresses the effects of the innovation (e.g., long-term/short-term; different segments of population that are affected).
5. Identify and describe how information sharing has affected this innovation.
 - a. Discuss the extent to which this innovation is dependent on the Internet.
 - b. Describe any security concerns and explain how they relate to the innovation.
6. Describe the beneficial as well as any harmful effects of the innovation you explored.

Learning Objectives

The **Explore – Implications of Computing Innovations** Performance Task addresses the following CSP Learning Objectives:

LO 1.1.1 Use computing tools and techniques to create artifacts. [P2]

LO 1.1.3 Analyze computational artifacts. [P4]

LO 1.2.1 Use computing tools and techniques for creative expression. [P2]

LO 3.3.1 Analyze the considerations involved in the computational manipulation of information. [P4]

LO 4.3.1 Appropriately connect problems and potential algorithmic solutions. [P1]

LO 7.1.1 Analyze how computing affects communication, interaction, and cognition. [P4]

LO 7.3.1 Analyze the beneficial and harmful effects of computing. [P4]

LO 7.4.1 Connect computing within economic, social, and cultural contexts. [P1]

Computer Science Principles

Performance Task: Create — Applications from Ideas

Programming is a creative process that involves individual and collaborative effort to bring ideas to life through designing, developing, testing, and debugging computational artifacts.

For this task, you and your partner will individually and collaboratively develop programs related to an area of focus of your choosing. You will be evaluated on your creativity and collaboration, as well as your ability to design algorithms, use abstraction, and program as you develop functioning computational artifacts.

General Requirements

You must develop and submit both an individual and a collaborative program for this task. You must work in pairs on the collaborative portion of this project. A group of three is only allowed if there is an odd number of students in the class.

Your team must identify an area of focus, and both the collaborative and individual programs must share that same area of focus.

Your team must collaboratively design and develop a program within the selected area of focus and submit a report.

You must work alone on the individual portions of this task. You must write the individual program, the reflection, and the report by yourself.

Both individual and collaborative work must demonstrate problem-solving skills and use complex programming constructs to complete the task.

Prepare and submit the following:

Collaborative Submission

For this submission, each group member must submit identical documents.

Develop a program along with your partner, in accordance with the Program Requirements (see **A** below).

Submit a written description of your group's program, as described in the Collaborative Report section (see **B** below), including prompts 5-9.

Individual Submission

Individually develop a program as described in the Program Requirements (**A**).

Submit a written description of your individual program, as described in the Individual Report section (**C**), including prompts 5-9.

Submit a reflection on the group's programming process for the collaboratively developed program, as described in the Individual Reflection section (**D**).

A. Program Requirements

All programs must meet the following requirements:

All program source code must be submitted in two ways: (1) a zip file of original source code from the programming environment and (2) a pdf document of cut-and-pasted code, either as text or a screenshot.

For each program, submit a video that displays the successful running of a portion of the program. The video must illustrate a portion of the intended purpose of the program and must have a maximum runtime of 1 minute. Submit the video using the following formats: .mov, .wmv, .mp4, or .avi.

Use the free screen capture software on each operating system platform. For example, on Mac OS you can use free QuickTime screen recording (.mov). On Windows operating systems, you can use Windows Movie Maker with the output format Windows Media Video (.wmv). Other options include screencast-o-matic.com (.mp4, .avi) or camstudio.com (.avi).

Each program must have an intended purpose that relates to the area of focus. Each program should be reasonably complex in demonstrating both the appropriateness of the programming language/environment you use and the significant work needed to create the intended functionality of your program.

- o Each program must include the basic programming elements of the language you use. For example, programs should demonstrate appropriate use of numbers, text, statements, mathematical expressions with arithmetic operators, logical and Boolean operators and expressions, and sets/list/other collections.
- o Each program should demonstrate the use of multiple abstractions in the programming language and creation of abstractions to develop and manage the complexity of the program (e.g., built-in and custom variables, data abstractions, functions/procedures, parameterization, APIs and libraries).
- o Each program should demonstrate the use of algorithms, including sequencing, selection, and/or iteration, as building blocks of the program.

The program you produce individually must be significantly different from the one you write collaboratively and from your partner's individually produced program.

The program you write independently can be written in a different language or in the same language as the program that you write collaboratively.

B. Collaborative Report

Respond directly to each of the following prompts.

1. State the area of focus your group chose to explore.
2. Describe the purpose of your collaborative program and how it relates to your area of focus. Your answer should be approximately 100 to 200 words.

3. Identify the language, programming environment (and which version you used), and the hardware and operating system on which you developed and tested your program.
4. **Respond to prompts 5–9.**

C. Individual Report

Respond directly to each of the following prompts.

1. Describe the purpose of your individually developed program and how it relates to your area of focus. Your answer should be approximately 100 to 200 words.
2. How does your individual program relate to the collaborative program, and how is it different? Your answer should be approximately 100 to 200 words.
3. Identify the language, programming environment (and which version you used), and the hardware and operating system on which you developed and tested your individual program.
4. **Respond to prompts 5–9.**

Prompts for Collaborative and Individual Reports (5-9)

5. Describe how a user runs and interacts with your program. Provide details that allow a novice user to experience the full functionality of your program. This must include sufficient detail for a novice user to perform actions such as clicking on buttons or filling in text boxes. He or she should be able to run your program from beginning to end. Your description should be approximately 300 to 400 words. Include supporting visuals and non-textual representations if needed (optional), and upload them as pdfs (maximum of 1 pdf).
6. Demonstrate that your program illustrates abstraction. Your answer should be approximately 200 to 300 words and include the following:
 - a. Identify and select a segment (or segments) of code from the program that illustrates the use of abstraction. Upload a pdf document with cut-and-pasted code, either as text or a screenshot. Your answer should be no more than one page of code.
 - b. Explain how the selected code illustrates the use of abstraction.
 - c. Explain how the code fits into the overall program you wrote.
 - d. Include supporting visuals and non-textual representations if needed (optional), and upload them as pdfs (maximum of 1 pdf).
7. Demonstrate that your program illustrates a complex algorithm. Your answer should be approximately 200 to 300 words and include the following:
 - a. Identify and select a segment or segments of code in the program that illustrates a complex algorithm. Upload a pdf document of cut-and-pasted code, either as text or a screenshot. Your answer should be no more than one page of code.
 - b. Describe the purpose of the selected algorithm and how it fits into the overall program you wrote.
 - c. Explain how the selected code implements the algorithm.
 - d. Include supporting visuals and non-textual representations if needed (optional), and upload them as pdfs (maximum of 1 pdf).
8. Explain how your program demonstrates the appropriateness and effectiveness of your chosen language and programming environment by describing your use of programming

elements and how they allowed you to manage the complexity of the program. Your answer should be approximately 200 to 300 words.

9. Identify and discuss one significant runtime error or bug you encountered while writing the program. Your answer should be approximately 200 to 300 words. Include:
 - a. What was the error or bug?
 - b. What process did you use to discover it?
 - c. What modifications did you make to the code to fix it?

D. Individual Reflection

Working on your own, write a brief reflection essay in which you describe the collaborative process you used to create your shared program and your collaborative report. Your answer should be no more than 300-400 words. Include answers to the following questions:

- a. How did you and your partner share or divide the work?
- b. What was the most significant contribution that you, individually, shared with your partner that helped to create the collaborative program or helped to identify and solve a problem that was encountered when developing the program?
- c. What was the most significant contribution that your partner, individually, shared with you that helped to create the collaborative program or helped to identify and solve a problem that was encountered when developing the program?
- d. What was the most significant question you asked – or significant feedback you provided – that helped your partner review and revise his or her program?
- e. What was the most significant question your partner asked – or feedback he or she provided – that helped you review and revise your program?

Learning Objectives

The **Create — Applications from Ideas** Performance Task addresses the following Computer Science Principles Learning Objectives (LOs):

- LO 1.1.1** Use computing tools and techniques to create artifacts. [P2]
- LO 1.1.2** Collaborate in the creation of computational artifacts. [P6]
- LO 1.1.3** Analyze computational artifacts. [P4]
- LO 1.2.1** Use computing tools and techniques for creative expression. [P2]
- LO 1.3.1** Use programming as a creative tool. [P2]
- LO 2.2.1** Develop an abstraction. [P2]
- LO 4.1.1** Develop an algorithm designed to be implemented to run on a computer. [P2]
- LO 4.2.1** Express an algorithm in language. [P5]
- LO 5.1.1** Explain how programs implement algorithms. [P3]
- LO 5.2.1** Use abstraction to manage complexity in programs. [P3]
- LO 5.3.1** Evaluate a program for correctness. [P4]
- LO 5.3.2** Develop a correct program. [P2]
- LO 5.3.3** Collaborate to solve a problem using programming. [P6]
- LO 5.4.1** Employ appropriate mathematical and logical concepts in programming. [P1]